ILLEGIB

3 March [redacted]

John,

Enclosed are quarterly reports on PAR's construed to be in the catagory of seeking to improve the state-of-the-art in printing, processing, or duplicating of original material as now controlled by [redacted] They are specifically: ILLEGIB [redacted]

1) PAR 206, "Reversal Processing of High-resolution Film Study" - [redacted]
2) PAR 207, "Definitive Study of Contact Printers" -- [redacted]
3) PAR 211, "Microdensitometer Study of Effects of Processing"-- [redacted]
4) PAR 213, "Color Reproduction Systems Review" -- [redacted]
5) PAR 214, "Roller Transport Reversal processor (12-inch)" -- [redacted]

The total dollar value of these actions is estimated to be [redacted] There is also attached a list of all current [redacted] tasks.

[redacted]

Declass Review by NGA.

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PAR 206

SECTION I

REPORT

[redacted]

25X1

PAR 206
30 Nov 64

SUBJECT: Reversal Processing of High Resolution Films Study

TASK/PROBLEM

1. Investigate and develop a reversal process for high resolution original negatives, duplicate positives, and duplicate negatives. Process to accomplish reversal with minimum loss of resolution.

DISCUSSION

2. Sensitometric Processing

a. Attempts to establish a reversal process for film Type 8430 on a production processor (Grafton) had been unsatisfactory in the past because of a consistent yellow highlight stain and too low a contrast. Since very little was known about the reversal characteristics of this film or any of the others which fitted into the scope of the study, laboratory investigation was performed using a sensitometric processor to collect information which could be used in solving problems of this nature.

b. The sensitometric processor was specifically designed for this type of experimentation. It can accommodate almost any processing cycle, has a small fluid capacity, a wide choice of operating temperatures and agitation rates, and can be operated by one man. Start-up and shut-down times are in the neighborhood of a few minutes while a full scale processor can easily require several hours. It should be noted that since it is an immersion type processor, data obtained with it will always be more closely related to deep-tank than to other types of full-scale processors, but with its use a great deal of insight can be gained into the results that can be produced with any processor.

c. The high-resolution films selected to meet the requirements of the study were:

Film Type No.	Normal Use
4404	Original Negative
4400	Original Negative
8430	Duplicating
SO-233	Duplicating

An attempt was made to establish Plus-X Reversal Film as a control emulsion with which the other films could be compared. This was not successful, however, since the films under investigation needed quite different process times and chemicals.

d. The laboratory program used the conventional reversal processing cycle: develop, stop, bleach, wash, clear, wash, reexpose, redevelop, wash, fix, wash and dry. The first series of experiments involved large changes in processing conditions for all except the wash stages of the cycle. In this way, some of the critical operating conditions were pointed out and used to design experiments for a finer measure of the necessary limitations of operating parameters. This kind of information is needed for production type processors which always have limitations in the amount of change that can be made in the process conditions of each stage. For instance, with a given bleach concentration and temperature, both the minimum and maximum time limits for satisfactory bleaching must be known. Too little bleaching results in a stain (unbleaching) while too much results in a mottled condition (re-reversal).

e. All of the samples of Type SO-233 tested had a yellow highlight stain and mottled condition. Since there appeared to be no quick method of improving the quality and since Film Type 8430 satisfied most of the program requirements for a duplicating film, Type SO-233 was dropped from the investigation.

f. The results with film Types 4404 and 8430 show that almost identical sensitometric results (emulsion speed, contrast, etc.) can be produced in reversal processing as in standard negative processing.

g. Film Type 4400 tolerance to changes in processing conditions is quite different from Types 4404 and 8430, so sensitometric testing with it has been delayed to minimize process changeovers. Enough has been learned, however, to show that no great problems should be encountered in establishing test processing conditions.

3. Full Scale Processing (Grafton)

a. The Grafton processor was used in the program for two weeks. It is a large scale production processor that has been modified to accommodate several different processing cycles. It is a deep tank processor (the first developer can also be converted to a spray chamber). It has automatic temperature control, nitrogen burst agitation, variable film travel speed, and can process all widths of film from 16mm to 9.5 inches. The plumbing between the chemical mix room and the processor is fitted with quick disconnects so the chemicals in any supply tank can be routed to any processing stage of the machine. This versatility allowed the processor to be converted from color processing to black-and-white reversal processing in only two days, including the twenty-four hours needed to decontaminate the system of residual color chemicals. A schematic of the Grafton is shown in Figure 1.

b. The Grafton had two undesirable features which should be remedied:

(1) The clearing bath stage was not followed by a wash.

(2) Only one tank of second development was available, which did not provide sufficient time for the chemical fogging developers. Several unused tanks could be utilized for these purposes if necessary changes are made in recirculation and heating systems.

c. The first developer stage of the Grafton was used as a deep tank rather than a spray system. There were two reasons for this:

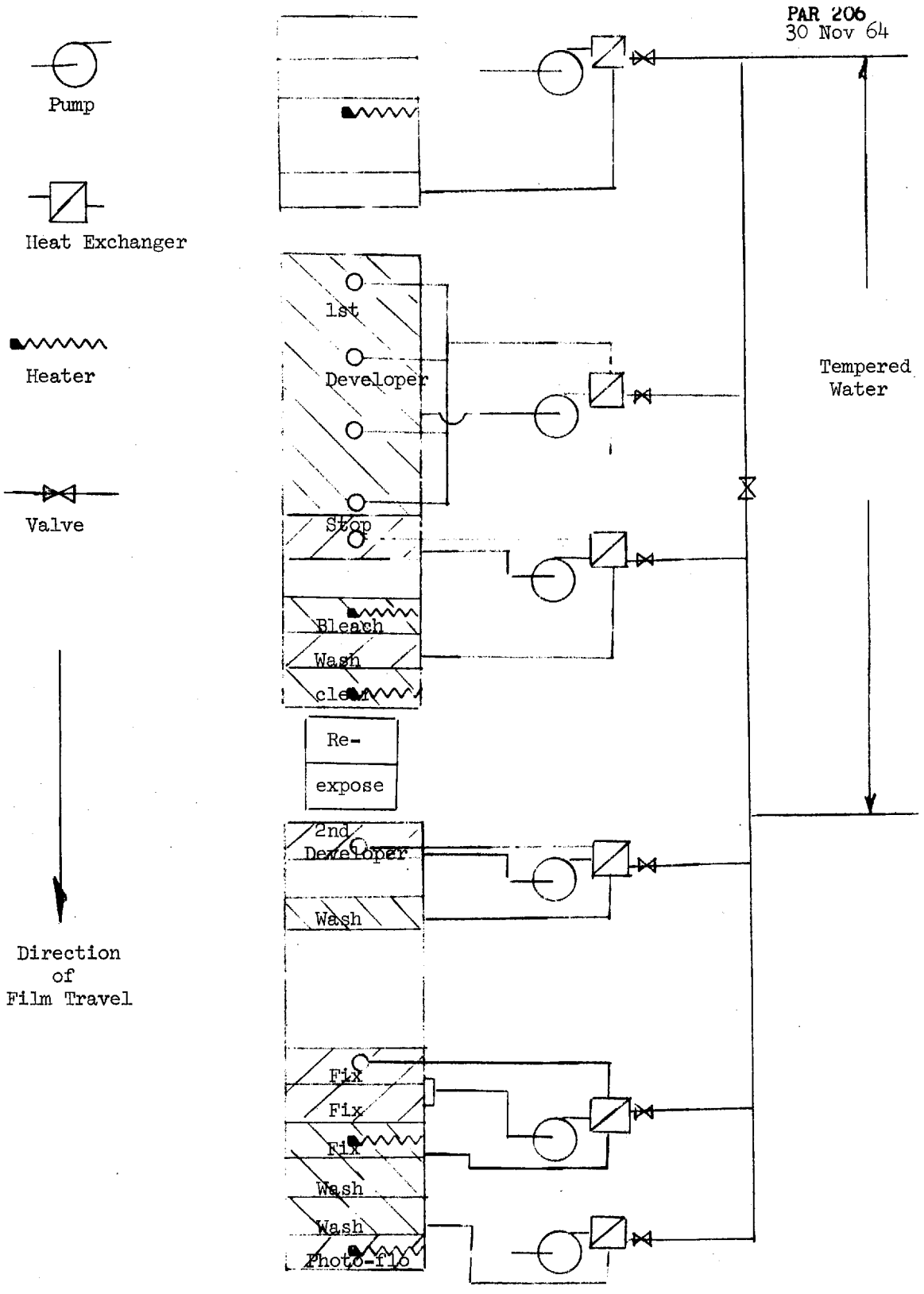

Figure 1. Schematic of Grafton processor. The tanks are labelled to show their use for black and white reversal processing. The unlabelled tanks are not used.

(1) The processing conditions that had been arrived at on the sensitometric processor would produce almost identical results in the deep tank system. This close correlation of effect probably saved at least three days of testing.

(2) The additional conversion time needed to install the spray system, and improve the process uniformity, was not warranted, since for the testing planned, a lower level of uniformity was acceptable. Of course, for extensive processing of high priority imagery, a spray system would be superior.

d. The sensitometric curves for the films processed on the Grafton are included in the report; Figure 2 for Type 8430, Figure 3 for Type 4404 and Figure 4 for Type 4400. The process temperatures, first development time, and first developer are listed in the figures. The remainder of each process was the same for all and is itemized in Table 1. The two curves for film Type 4400 in Figure 4 show the separate effects of visible light reexposure and chemical fogging.

e. A resolving power series was generated with film Type 8430. High contrast, sixth root of two, 80 to 800 l/mm range targets of both polarities were used. The polarities correspond to dark bars on a clear surround and clear bars on a dark surround. The resolution values contained in the master target format and their group codings are listed in Table 2. All first generation printings were made with U.V. light on a vacuum board. The higher generations were printed with a Niagara printer. The processed targets were read independently by several different people. No large differences in the data were found between individuals. The resolution values from the series that first aroused interest in the present study and the values from the latest tests are shown in Figure 5. The original values, denoted "0", were obtained with the clear bar on a dark surround target, and should be compared to the "C" values.

PAR 206

Emulsion 8430 **Date** 30 Nov 64

Experimenter Date Witness Date

EXPOSURE

Sensitometer IB

Filter

Exposure Time Log E_{11} = 1.38

PROCESSING

Gamma	D-min
1.30	.12

75°F process with MPB-101D 1st developer for 2 minutes 30 seconds. See Table 1 for remainder of process.

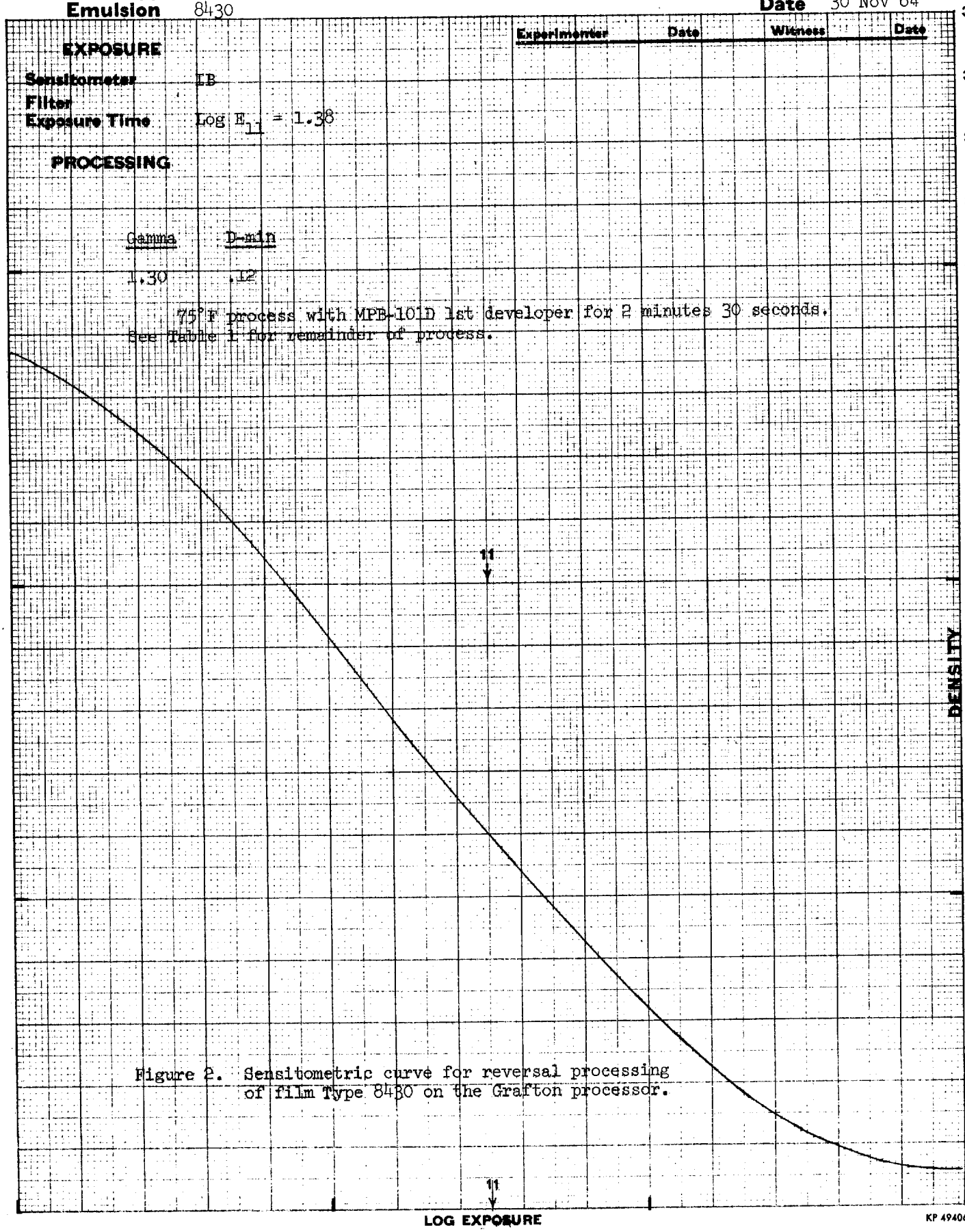

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Figure 2. Sensitometric curve for reversal processing of film Type 8430 on the Grafton processor.

Emulsion 4404 **Date** 30 Nov 64

EXPOSURE

Sensitometer IB
Filter
Exposure Time Log E_{11} = 1.30

PROCESSING

Gamma	0.60/Speed	D-min
2.30	1.12	.09

75°F process with MPB-111D 1st developer for 3 minutes.
See Table 1 for remainder of process.

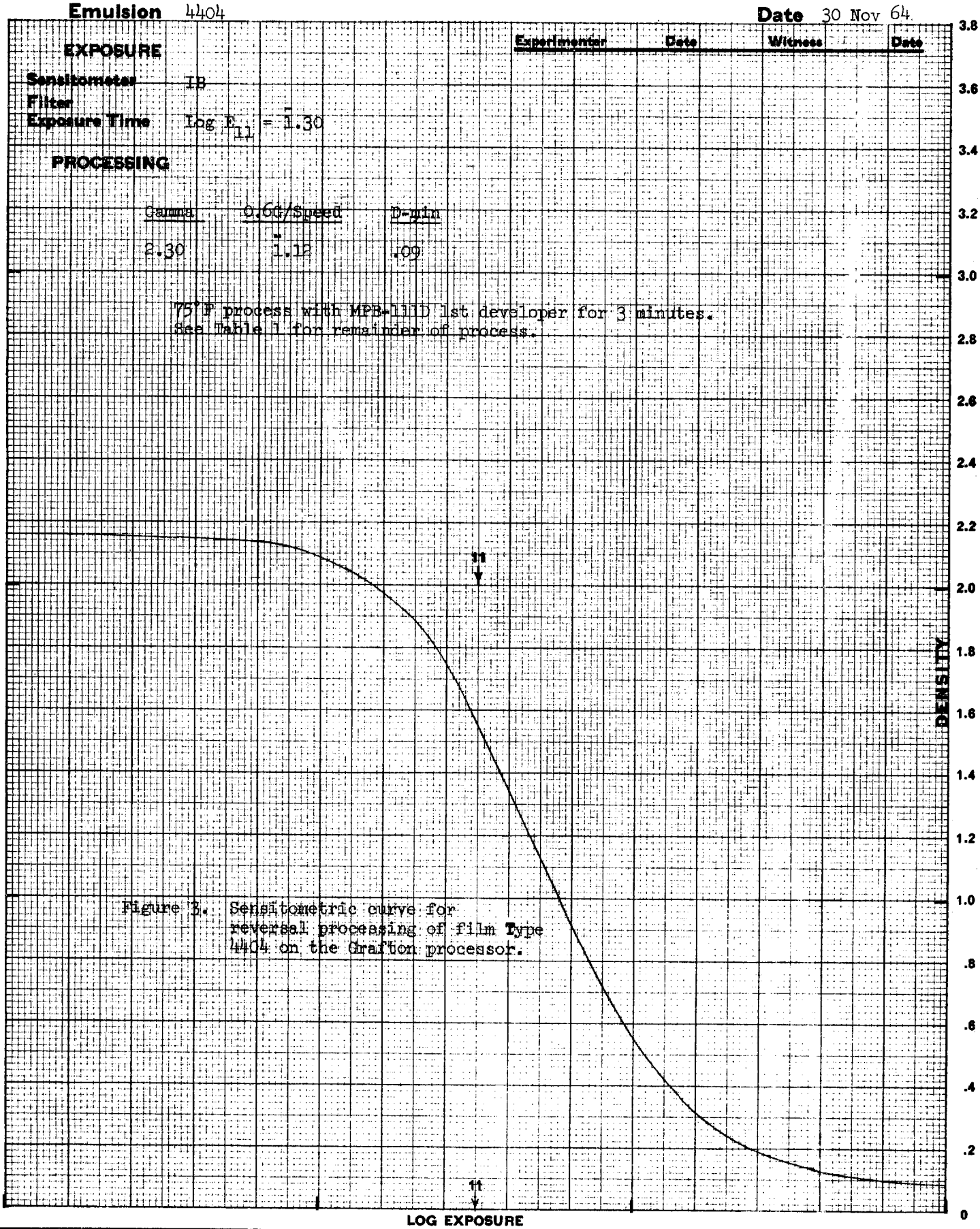

Figure 3. Sensitometric curve for reversal processing of film Type 4404 on the Grafton processor.

Emulsion 4400 Date 30 Nov 64

Experimenter Date Witness Date

EXPOSURE

Sensitometer IB

Filter -

Exposure Time $\log E_{11} = 2.70$

PROCESSING

Curve	Gamma	0.60/Speed	D-min
1	1.45	2.14	.11
2	1.00	3.78	.11

Both curves were produced in a 68°F process with D94 1st developer for 1 minute and 45 seconds. The processing conditions shown in Table 1 were also used except that for Curve 2 a fogging 2nd developer, FD-68 was used instead of visible light re-exposure and D-95 re-developer.

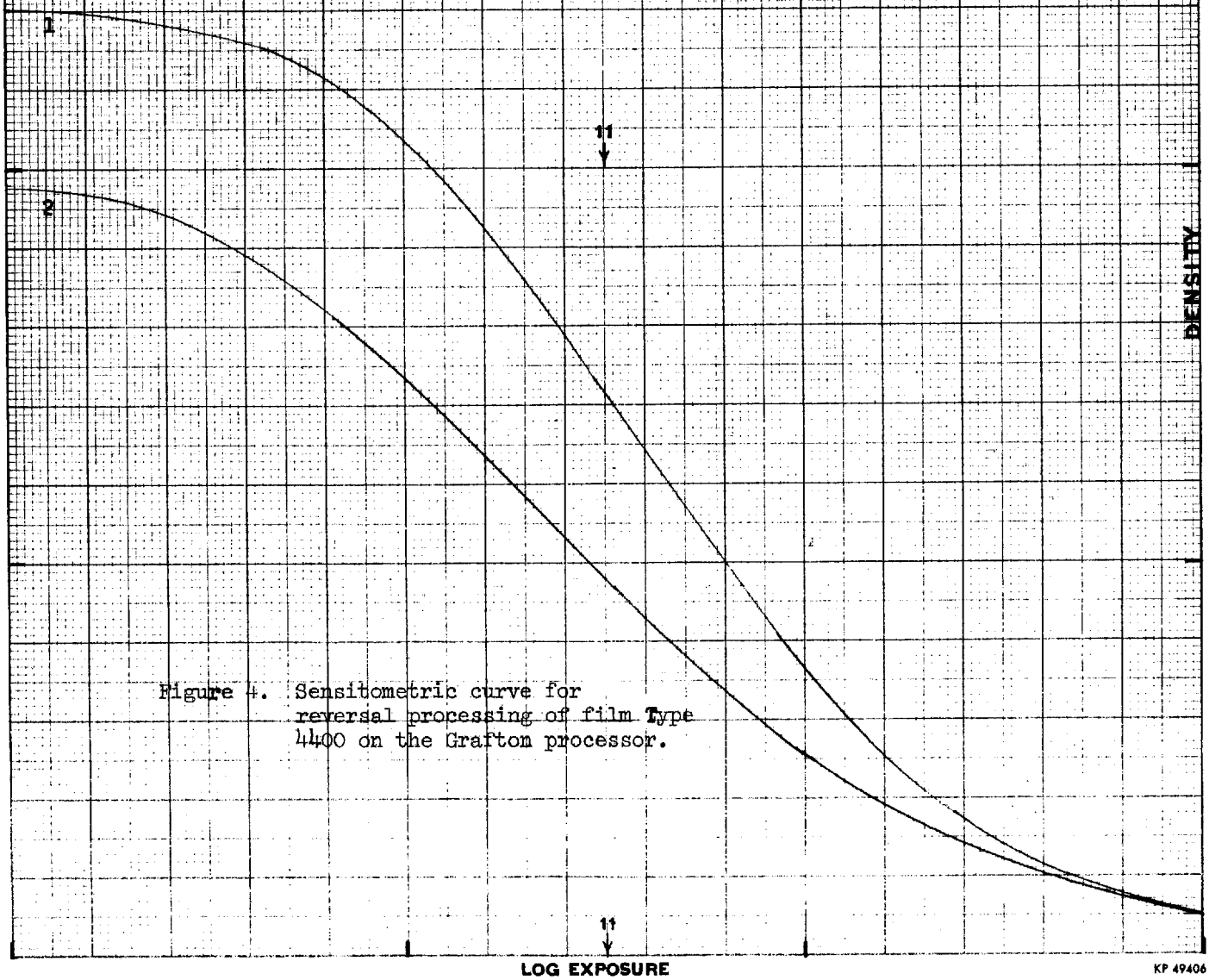

Figure 4. Sensitometric curve for reversal processing of film Type 4400 on the Grafton processor.

Processing Stage	Chemical	Time
Develop	See appropriate Figure	
Stop	SB5B	1'00"
Bleach	R9	1'12"
Wash	Water	1'12"
Clear	CB-3	1'27"
Re-expose	1600 fcs (through base)	--
Re-develop	D95	58"
Wash	Water	1'12"
Fix	F-6	3'40"
Wash	Water	2'28"
Photo-flo	P-F	1'12"

Table 1. Processing conditions on the Grafton for all stages except the 1st developer which produced the curves shown in Figures 2, 3, and 4 for film Types 8430, 4404, and 4400 respectively. The chemical formulas will be included in the final report.

Step Number	Group Number			
	6	7	8	9
1	79.3	158.6	317.0	634.0
2	88.4	176.8	353.6	707.2
3	99.1	198.3	396.3	793.0
4	110.5	221.0	442.0	
5	124.8	249.6	499.2	
6	135.1	278.2	556.4	

Table 2. This table lists the resolving power values in lines per mm contained in the targets used to generate the data shown in Figure 5. The values are usually reported in terms of the Group and Step numbers; e.g. 8/2 in stead of 353.6 l/mm.

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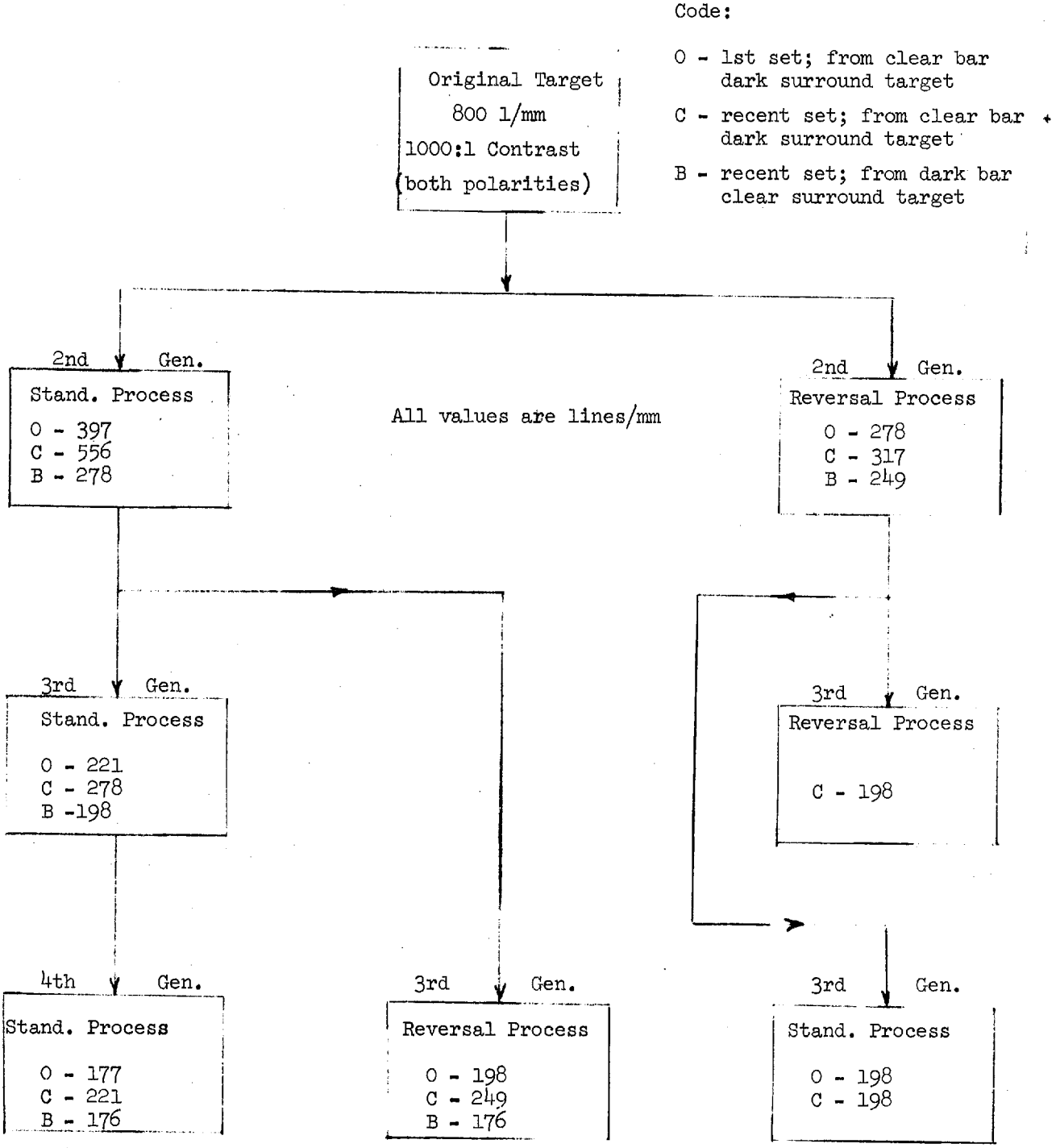


Figure 5. Resolution values obtained with Type 8430 film. The "O" values, the 1st set generated by the study should be compared to the "C" values of the more recent Grafton tests.

f. In all the steps of the series except one, the latest values are higher. This increase might be accounted for by improved printing methods. Most important, however, is the fact that earlier results were confirmed; that is, more information of an original film will be retained in a duplicate negative if it is obtained as a second generation product of a reversal process rather than a third generation product of a standard negative process (corresponds to third and fourth generation comparisons in the test series, Figure 5). The resolution values from the dark bar on a clear surround target were, as expected, much lower than the opposite polarity.

g. A third generation negative copy was made of some typical reconnaissance scenes on 9.5 inch Type 4400 film and was used as a simulated original negative. Part of this was reversal processed with white light reexposure and part with a fogging type second developer. An examination of the sensitometric curves in Figure 4 will show that a lower maximum density was obtained with the chemical reexposure than with light. This was due to insufficient second development time and can be corrected by the suggested changes in the Grafton, Paragraph 3.b.(2).

h. Image material on film Types 8430 and 4404 was processed along with the resolution targets and essentially the same type of generation series was obtained. Some of this material was arranged in transparent folders so the various generation steps could be easily compared. All of the materials demonstrated that satisfactory results can be obtained with film Types 8430 and 4404 and 4400 in terms of tone, contrast, and film speed. Several hundred feet of imagery is on hand and is available for viewing.

i. A complete review of this program was given for the customer representative on 19 November 1964. All of the major steps from its beginning

to its present status were outlined. The resolution data and the image material displayed for viewing gave rise to the major part of the discussions.

PLANNED ACTIVITIES

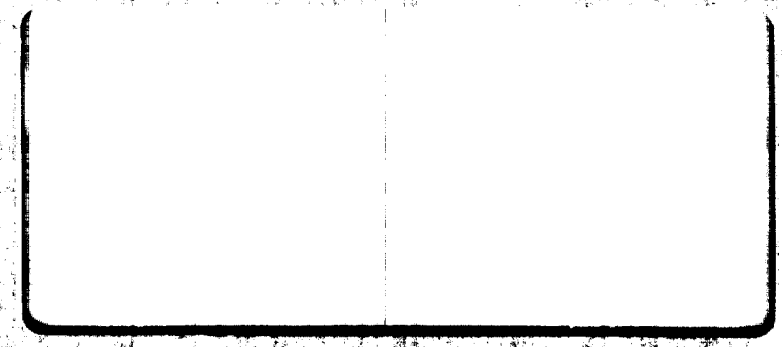
4. Resolving power experiments are planned for film Types 8430, 4404, and 4400 on the sensitometric processor. The effects to be determined are:

a. Fogging second developers
b. U.V. enhancement
c. Reexposure levels
d. Fine grain developers
e. Bleach times

Targets of both polarities, based on twelfth root of two imcrements, will be used to provide twice the sensitivity of measurement as those used in the past. These targets are being constructed and should be available soon.

5. Tests will be continued to obtain background data needed for potential production operation.

PAR-307



25X1

PAR 207
30 Nov 64

SUBJECT: Definitive Study of Contact Printers

TASK/PROBLEM

1. Conduct a comprehensive evaluation of existing contact printers, i.e., flat bed, step and repeat, and drum platen (continuous types). Primary objective is to determine printers and/or techniques that will provide maximum fidelity of duplication.

DISCUSSION

2. Image evaluation by such techniques as spread function and modulation transfer function will be investigated as part of this PAR. However, greater current practicality is evident in the direct determination of resolving power. Using the standard Air Force Resolution Target (1951), investigation is in progress to establish the relationship between high contrast, medium contrast and low contrast test objects. Also, the difference between negative and positive type resolution targets and the effect of exposure level on resolution are being studied.

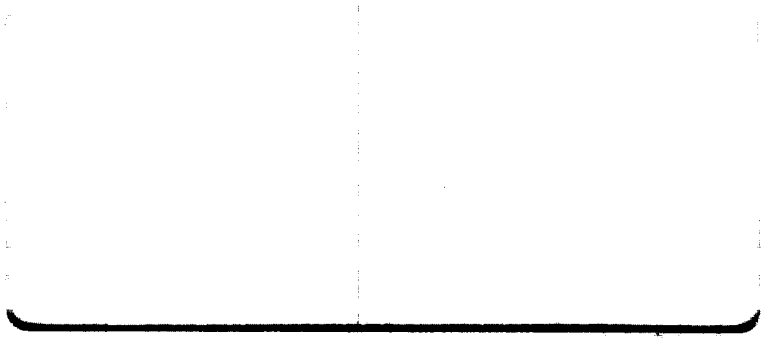
3. Moire' patterns resulting from printed half-tones are being investigated as a means of locating and measuring distortion. Both local and general distortion problems are considered. Using master glass plates as the reference standards, film-base working master halftones have been prepared for actual printing tests. In general, the third-generation halftone prints produced on the printer will be matched against the film-base second-generation masters. Some time has been spent modifying vacuum hold-down equipment and perfecting necessary handling techniques for doing this. Also, means of reproducing the Moire' patterns both manually and photographically were evolved to aid in the precise calculation of distortion magnitudes.

4. A review of progress with customer representatives was held on 19 November 1964. Moire' patterns and knife edge test targets were discussed at this review.

PLANNED ACTIVITIES

5. Renewed effort to obtain satisfactory test objects for acutance determinations will be started shortly. Work described in paragraphs 2. and 3. above will continue as concurrent effort.

6. Rough draft sketches of proposed briefing aids will be made and forwarded to the customer.



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PAR 211
30 Nov 64

SUBJECT: Microdensitometer Study of Effects of Processing

TASK/PROBLEM

1. Collect and study microdensitometric data from mission materials in an attempt to determine the effects of film emulsions, processing, and printing on the characteristics of image edges. Also, attempt to determine true location of image edges for mensuration purposes.

DISCUSSION

2. Data was collected on low-contrast resolving power, acutance, granularity, and modulation transfer of Types 4400, 4401, and 4404 films under standard Trenton three-condition processing and in four special low graininess or high-sharpness developers. To facilitate acutance measurements, the microdensitometer was modified to permit direct card punching of the density data. This data is reduced in the IBM 1620 or 7044 computers through the use of computer programs written during this quarter. IBM 7044 programming is preferred for the advantages offered in speed and efficiency versus the IBM 1620 computer.

3. Briefing aid designs are in preparation for use in describing this project.

4. A literature search and preliminary investigations were made on the problem of the mensuration of photographic images at the limit of resolution. This is the difficult problem of distinguishing a signal almost buried in noise, and appears so far to have only partial solutions. The variables of lens aberrations, uncompensated image motion, and haze add to the grain of the film in smearing edge, so that it seems necessary to characterize the edge spreading as a fundamental stage of mensuration.

5. The customer has shown interest in adding medium contrast (6.3:1) resolving power to the other image quality measurements made on the films having processing variations. Also, he would like to have aerial scene simulations made at 1:300,000; 1:100,000; and 1:23,000 (only two scales were included in the original proposal). Quotations are being prepared to show the cost of including these two additions to the contract.

PLANNED ACTIVITIES

6. Data collection continues on the image quality of films having fine grain and high resolving power processing.

7. Briefing aid designs will be completed and submitted to the customer for approval.

8. Cost estimates will be prepared on the inclusion of medium contrast resolving power as one of the image quality tests, and a third scale (1:23,000) as one of the scales used in making scene simulations.

9. The mensuration study will be continued.

PAR-213

25X1

PAR 214
30 Nov 64

SUBJECT: Roller Transport Reversal Processor (12 Inch)

TASK/PROBLEM

1. Design and fabricate a versatile, self-threading photographic processor capable of handling both cut sheets and continuous webs of photographic material and adaptable to a process yielding either standard negative or reversal images. Interchange between processes to be accomplished with a minimum of effort.

DISCUSSION

2. During this reporting period (1 Sept through 30 Nov) all subassemblies and detail drawings on the processing machine and dryer were completed and released for fabrication. A design study of the recirculating systems and the attendant piping was completed. As a result of this study, pumps, heat exchangers, filters, flow-meters and other required hardware were prelisted and ordered.

3. Design effort is continuing on the pumping system, the control panel and all associated piping.

4. Preliminary installation engineering data sheets were completed and submitted.

5. A revised specification for the processing machine was written following the Progress Review Meeting held at the contractor's facility on 19 and 20 November 1964. A copy of the revised specification is being submitted as an appendix to this report.

PLANNED ACTIVITY

6. Continue design effort as planned.

7. Visit customer's facility to inspect installation site and to coordinate design effort with customer's requirements.

Note: See Specification 203B attached.

Specification No. 203B
30 Nov 64

SPECIFICATION

FOR

REVERSAL ROLLER TRANSPORT PROCESSOR (12-INCH)

TASK/PROBLEM

1. Design and fabricate a versatile, self-threading photographic processor capable of handling both cut sheets and continuous webs of photographic material and adaptable to a process yielding either standard negative or reversal images. Interchange between processes to be accomplished with a minimum of effort.

PROCESSING METHOD

2. Roller transport conveyance through deep tanks. Agitation accomplished by action of the conveying rollers.

MATERIAL CAPABILITIES

3. Film Size:

a. Cut Sheet:

(1) Minimum 4 x 5 inches.

(2) Maximum 11 x 14 inches.

NOTE: Cut sheet films must be packaged and shipped in cut sheet form, not cut from roll stock.

b. Continuous Strip:

(1) Minimum 70mm x 1,000 feet.

(2) Maximum 9.5 inches x 1,000 feet.

4. Material: Certain types of black-and-white aerial and commercial films.

NOTE: It should be recognized that with roller transport equipment, some of the thin base materials may require a pilot tab at the leading edge in order to be self-threading.

OUTPUT RATES

5. Process Time (Approximately):

a. Reversal Process - Film similar to:

(1)	Film Type 8430	6.4 ft/min. at 75°F
(2)	Film Type 4400	6.85 ft/min. at 70°F
(3)	Film Type 4404	5.33 ft/min.

b. Negative Process - Film similar to:

(1)	Film Type 4404	26 ft/min. at 85°F
(2)	Film Type 8402	16 ft/min. at 85°F
(3)	Film Type 8430	20.4 ft/min. at 75°F

PROCESS TIME

6. Dry to Dry (Approximately):

a. Reversal Process

(1)	Film Type 4400	9 minutes
(2)	Film Type 8430	11 minutes
(3)	Film Type 4404	14 minutes

b. Negative Process

(1)	Film Type 4404	3 minutes
(2)	Film Type 8430	4 minutes
(3)	Film Type 8402	5 minutes

PRODUCT QUALITY

7. Negative: Good commercial quality (approximately five years).

8. Reversal: No experience (probably 5 years).

9. Process temperature capability 70°F to 100°F. Operating range for above films 70°F to 85°F.

10. Reversal Capability: Equipment to be capable of reversing image of both exposures by both chemical fogging and/or white light flashing.

11. Operation: Daylight operating for all continuous strip material up to capacity of A-9 magazine. Darkroom feed for all cut sheet material.

PHYSICAL DIMENSIONS

12. Over-all Dimensions:

a.	Length	15 feet, 9 inches.
b.	Width	5 feet.
c.	Height	5 feet, 6 inches.
d.	Weight	7,000 pounds, installed, empty.

SERVICE REQUIREMENTS

13. Service Requirements:

a.	Electrical:	220/208 volts, 50 amperes, 60 cps, AC, 3-phase
b.	Water:	Hot 130° ± 10°F; Chilled: 50° ± 5°F, 30 psig minimum.
c.	Air:	25 psig maximum, instrument air.